2017 ASPECT Preliminary Report
Arkema Plant Response, Crosby, TX
&
Rapids Needs Assessment

September 1, 2017
0500 hrs to 1800 hrs

Figure 1: Infrared Image of two refrigerated containers at the Arkmen Facility on 31 August 2017

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1 Background

On 30 August 2017 at 0445 hrs the US EPA Region 6 On-Scene Coordinator Byrant Smalley contacted ASPECT Program Manager, Dr. Mark Thomas, to activate the ASPECT aircraft and respond to the Arkema Facility explosion located in Crosby, Texas. The facility produces liquid organic peroxides that are used mainly in the production of plastic resins. The explosion was a result of a loss of refrigeration in temporary storage trailers.

After conducting three flights on 31 August 2017, the ASPECT aircrew will move their base of operations from Addison Airfield to Hobby Airfield. Pending any maintenance issues, this will position the aircraft closer to the target areas and reduce the transit time by more than one hour. The ASPECT technical reach-back team will remain in Addison, TX.

A detailed summary of the ASPECT operations on 31 August 2017 is available in a different report. This report will begin with a detailed summary of the ASPECT operations scheduled for 1 September 2017. Table 1 provides a brief summary of the ASPECT products to date.

Date	*# Sorties*	*Aerial Photos*	*Oblique Photos#*	*FTIR spectra**
30 August 2017	1	39	52	21,000
31 August 2017	3	173	221	117,000

Some photos were not be viewable/usable due to poor lighting or weather conditions at the time they were taken.
* The collection frequency of FTIR spectra is 70 spectra per second.

ASPECT continues to fly in the TFR area (Temporary Flight Restriction) under an assigned squawk code in close coordination with the U.S. Coast Guard. The aircraft does not fly through known chemical plumes or take air samples. It uses a passive remote sensing technology that can detection vapors at its routine survey altitude of about 3,000 ft above the hazard.

ASPECT products are viewable using Google Earth by using the Google Earth "n-link" file which can be made available by contacting EPA R6 officials.

2 Aircraft Capabilities used on this survey

Chemical Detection:
The US EPA ASPECT system collects airborne infrared (IR) images and chemical screening data from a safe distance over the site (about 2,800 AGL). The ASPECT System is an emergency response aircraft permitting remote chemical detection in support of the first responder. The system consists of an airborne high speed Fourier transform infrared spectrometer (FTIR) coupled with a wide-area IR line scanner. The ASPECT IR systems have the ability to detect compounds in both the 8 to 12 micron (800 to 1200 cm-1) and 3 to 5 micron (2000 to 3200 cm-1) regions. The 8 to 12 micron region is typically known as the atmospheric window region since the band is reasonably void of water and carbon dioxide influence. Spectrally, this region is used to detect carbon—non-carbon bonded compounds. The 3 to 5 micron region is also free of water and carbon dioxide but typically does not have sufficient energy for use. This band does show use in high-energy environments such as fires. The Carbon – Hydrogen stretch is very common in this region.

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Photo Capabilities:
A still digital Nikon DX2 camera collects visible aerial imagery as part of the core data product package. It consists of a 12.4 mega pixel CMOS camera supporting a 3:5 aspect ratio frame. The system uses a 28 mm wide-angle lens and is slaved to the primary IR sensors and provides concurrent image collection when other sensors are triggered. All imagery is geo-rectified using both aircraft attitude correction (pitch, yaw, and roll) and GPS positional information. Imagery can be processed while the aircraft is in flight status or approximately 600 frames per hour can be automatically batch processed once the data is downloaded from the aircraft.

An Imperx mapping camera provides a similar aspect ratio and aerial coverage at a much higher resolution (29 mega pixels). Like the Nikon DX2, it is slaved to the primary IR sensors and provided concurrent image collection when other sensors are triggered. These images are often digitally processed in lower resolution so they can be transmitted via satellite communication. The high resolution images are pulled from the ASPECT after the sortie and often made available at a later time.

Data are processed using onboard algorithms while the aircraft is in flight and preliminary results are sent using a satellite system to the ASPECT reach back team for QA/QC analysis. The reach back team is operating from small hanger offices located at Million Air, Addison, TX.

3 Results

Flight #6

0530 hrs: ASPECT was airborne by 0530 hrs CST to monitor the Arkema facility. They expect to be over the facility about 0650 hrs. The aircraft with loiter near the facility and make periodic (every 30 minutes) chemical screening measurements over the facility.

A second mission will be begin later today to provide rapid needs assessment of selected targets east and northeast of the Houston area. The targets were provided by Region 6 and include Remedial Management Plan (RMP) locations, wastewater facilities, water treatment facilities, and National Priority List (NPL) sites. Flight paths are being developed to collect aerial images over about several hundred target sites.

Weather conditions over Crosby, TX are partly cloudy with about 10 miles of visibility. Light winds from the north at ground level (pressure 1015 mbar). The surface temperature is 21°C with a humidity of 93%.

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0720 hrs: ASPECT made numerous passes over the facility and there were no significant chemical detections. The crew reported that the IR video showed that the trailers are cool. See Figure 2.

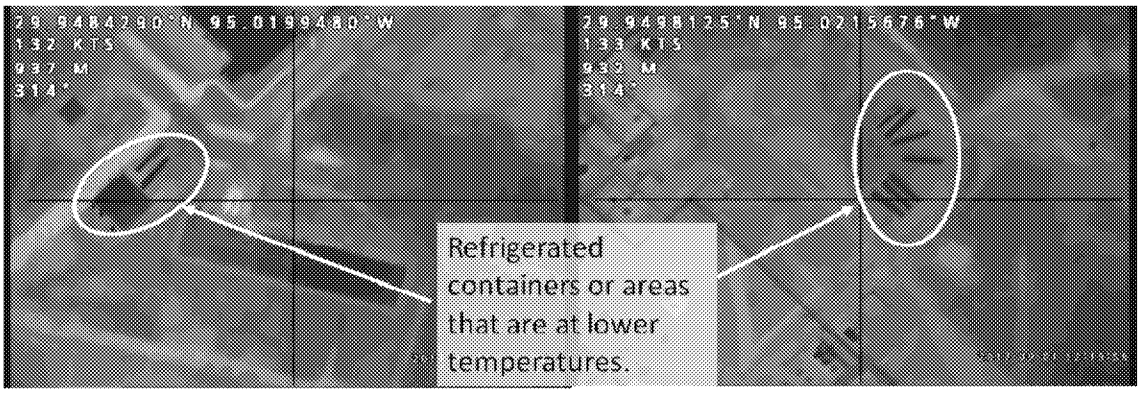

Figure 2: Infrared images obtained from an infrared video (0615 hrs CST) clearly show that the containers are being cooled (black colors) at the Arkema facility.

0750 hrs: ASPECT made numerous passes over the facility and there were no significant chemical detections. IR video continues to show similar images as shown in Figure 2.

0830 hrs: ASPECT made numerous passes over the facility and there were no significant chemical detections. IR video continues to show similar images as shown in Figure 2.

0900 hrs: ASPECT is heading to Hobby Airfield to refuel and upload data.

1100 hrs: ASPECT is airborne and will continue to monitor the Arkeman site every 30-45 minutes. Between the Arkeman monitoring passes, ASPECT will conduct rapid needs assessment surveys over specific targets provided by the Region. There are several hundred sites to be photographed throughout Texas, so these have been categorized into several geographical zones. Zone 5 (Figure 3) is closest to the Arkeman site, so ASPECT will begin to capture aerial photos over about 50 targets via 36 flight lines. If the site is an industrial plant, the chemical sensors will be activated.

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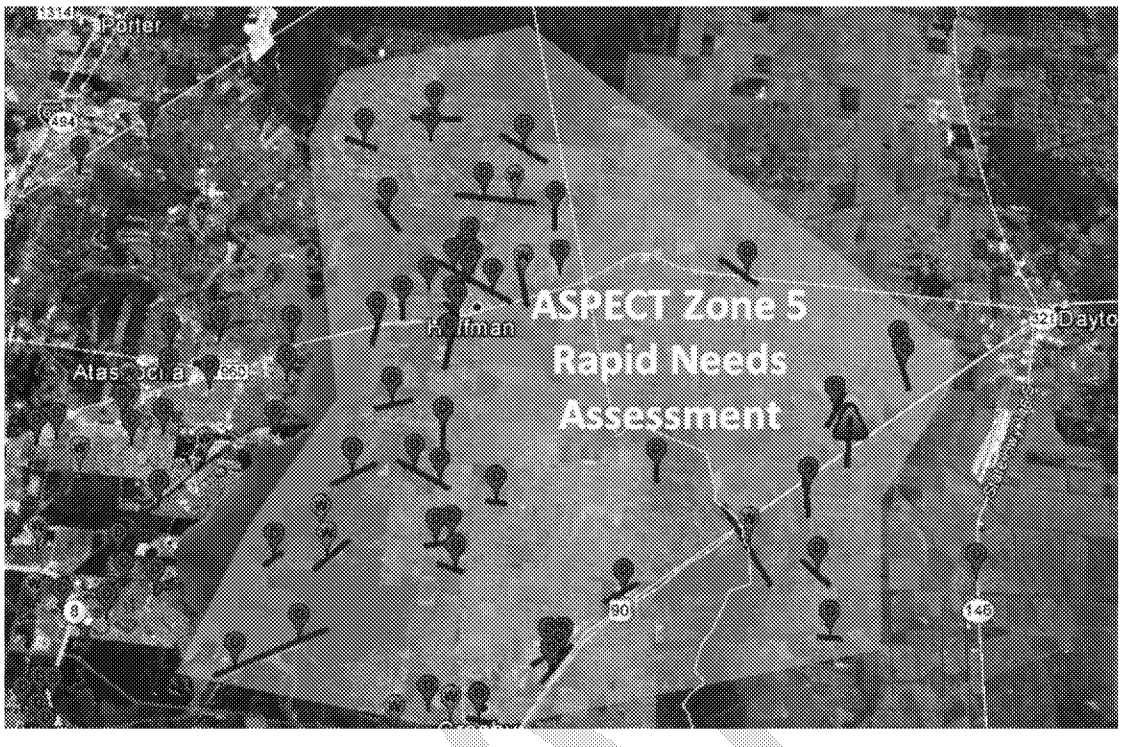

Figure 3: Zone 5 (highlighted area) contains more than 50 targets and 36 flight lines where ASPECT will collect high-resolution aerial photographs. If the target is an industrial facility, the chemical sensors will be activated. "D" icons are drinking water facilities. "W" icons are wastewater treatment facilities. "!" icons are Risk Management Plan sites. Several of the locations are not accurate so it may appear as if they are not covered by the flight line.

1141 hrs: ASPECT made numerous passes over the facility and there were no significant chemical detections. IR video continues to show similar images as shown in Figure 2.

1225 hrs: ASPECT has completed 11 of 36 flight lines in Zone 5.

1240 hrs: ASPECT made numerous passes over the facility and there were several detections about 50 m downwind from the facility (wind direction was coming from 350 degrees with wind speeds less than 2 m/s) showing weak (e.g., slightly above the 5.3 ppm detection limit) signatures consistent with peroxide. Figure 4 is an image from the infrared video which indicates that the northernmost trailer looks warmer than the surrounding trailers. Figure 5 is an image of an oblique photo taken on 30 August of the trailers shown in Figure 4.

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Figure 4: Image taken from the infrared video showing that one trailer looks warmer (e.g., colored white) than the surrounding trailers. The time stamp is UTC time; local time is 6 hours behind (1144 hrs CST).

Figure 5: Oblique photo taken on 30 August 2017 of the trailers shown in Figure 4.

The aircraft will continue to monitor the site about every 30-45 minutes and make progress on the rapids needs assessment targets in Zone 5. ASPECT currently has about 3 hours of fuel remaining.

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1330 hrs: ASPECT made numerous passes over the facility and there were no significant chemical detections. IR video continues to show similar images as shown in Figure 4.

1430 hrs: ASPECT made numerous passes over the facility and there were no significant chemical detections. IR video continues to show similar images as shown in Figure 4.

1530 hrs: ASPECT made numerous passes over the facility and there were no significant chemical detections. IR video continues to show similar images as shown in Figure 4. ASPECT also completed Rapid Needs Assessment lines 12 through 36, completing aerial and chemical surveys for Zone 5. About 160 photos were collected and will be processed ASAP.

The aircraft and crew returned to Hobby Airfield to refuel and upload the data.

1640 hrs: Roberto Bernier, R6 OSC, called Mark Thomas and reported that white smoke was rising from several trailers at the Arkamen site. The crew is preparing to respond to conduct chemical monitoring and collect aerial photographs.

1710 hrs: ASPECT was airborne and arrived on site by 1725 hrs. Initial reports from the crew reported a yellow plume rising to 3,000 ft AGL. The crew increased altitude to 4,000 ft AGL to take aerial and oblique photos as well as conducting chemical sweeps over the site. Figure 6 shows the plume coming from the trailer(s) which were on fire. The image to right is an oblique image taken from the aircraft on 31 August 2017.

Figure 6: Thumbnail image (left, very low resolution) taken from the aircraft during the response. Oblique image showing the trailers that eventually caught fire.

1740 hrs: ASPECT preliminary measurements showed no significant chemical detections which indicates an efficient burn. However, follow up surveys did detect low levels of 1-butene and PAN (Polyacrylonitrile) indicating a transition of the fire

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from high to lower temperatures thus creating byproducts of incomplete combustion. Based upon this fire, the life cycle of one of these trailers/containers appears to be about 60 minutes.

1800 hrs: Figures 7 & 8 show intense heat where the trailers are on fire. Figure 7 is an image that was pulled from the aircraft while in flight. Figure 8 was obtained after the aircraft landed

Figure 7: Infrared image obtained from an infrared video taken during the fire.

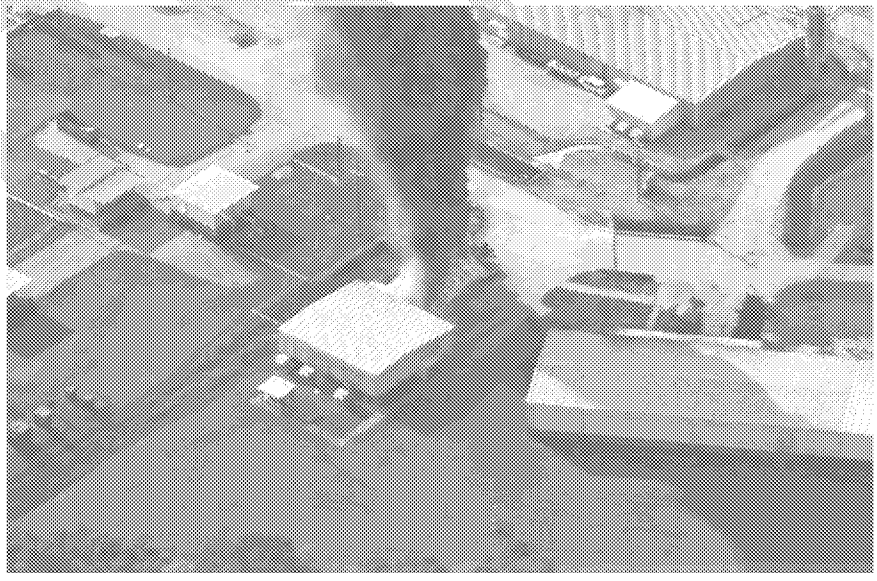

Figure 8: Oblique image of the trailers on fire.

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1815 hrs: The aircraft remained on station, making 19 passes over the fire to continue monitoring and collect photos. Figure 8 illustrates the spectral characteristics of a typical hot fire. The primary constituents observed in this spectra are ozone, benzoyl peroxide, trace quantities of hot carbon dioxide and possibly small amounts of 1-butene (combustion products).

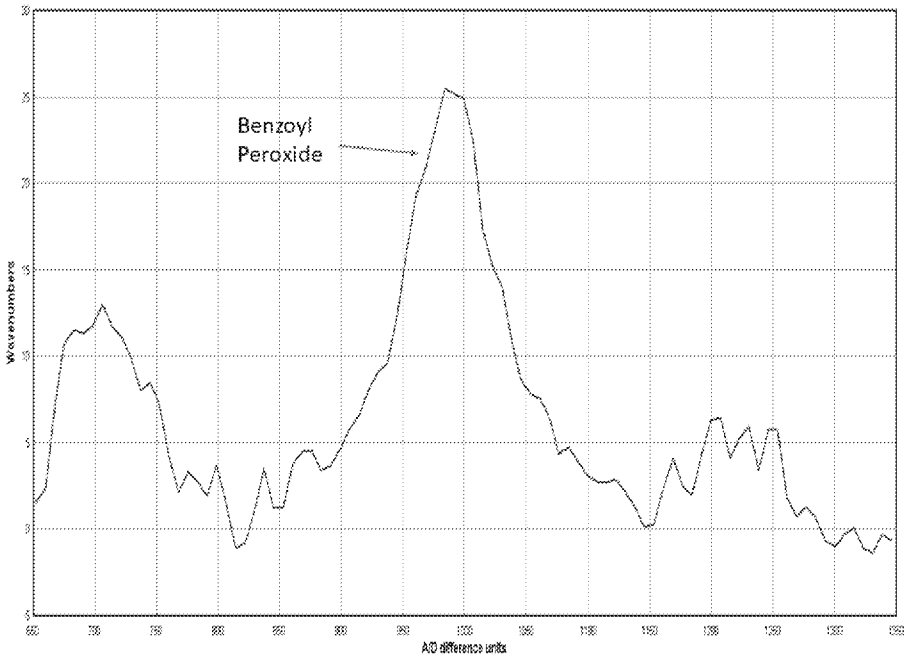

Figure 9: Image of the FTIR spectra collected over the fire. Primary constituents observed in this spectra are ozone, benzoyl peroxide, trace quantities of hot carbon dioxide and possibly small amounts of 1-butene (combustion products).

1850 hrs: ASPECT returned to base to upload the data and rest. The crew will be available for flight operations at 0700 hrs 2 September 2017.

4 Operational Challenges

1. Satellite communications became unstable throughout the day. We continue to monitor this situation.

2. The technical reach-back team continues to actively address recording issues with the infrared line scanner (IRLS) system. It appears that the recording computer failed in the aircraft on 31 August 2017. Overnight, the team replaced the IRLS motherboard and conducted a test flight. Results indicated that the issues had been resolved but during Flight 6 (1 September 2017) similar faults were observed, suggesting that the cause is more complex. Currently this capability is not available. The night vision camera has been reconfigured as a thermal imaging system as a backup. Efforts to fix

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the IRLS continue, however a fix cannot occur until the team completes a critical examination of the system. That work cannot occur while the aircraft is stationed at Hobby Airfield.

3. The ASPECT program is assessing the work/rest cycle for the flight crew. The program operates under 14 CFR Part 91 which allows for flexibility in the duration that flight crews can operate. However, there is a practical limitation where operations can continue with an adequate margin of safety. This factor will impact our response capability and may result in no coverage should an emergency occur.

5 ASPECT Team and Crew

Dr. Mark Thomas, ASPECT Program Manager
Dr. John Cardarelli II, ASPECT Radiological / Tech Lead
Mr. Timothy Curry, ASPECT Logistics/Finance Lead
Dr. Robert Kroutil, Kalman Co Inc.ASPECT Chemical / GIS Lead (contractor)
Dr. Brian Dess, Kalman Co Inc. ASPECT Chemical / IT support (contractor)
Mr. Jeff Stapleton, Kalman Co Inc. (remote support)
Ms. Malia Smolenski, Kalman Co Inc. (remote support)

Sam Fritcher, Airborne ASPECT Inc., CEO
Beorn Leger, Airborne ASPECT Inc., Chief Pilot
Ned Conner, Airborne ASPECT Inc., Pilot
Tom Cruise, Airborne ASPECT Inc., ATP/Operator
Dallas Sley, Airborne ASPECT Inc., Equipment Operator
Robert Kirby, Airborne ASPECT Inc., Engineer
Bruce Dingman, Airborne ASPECT Engineering Tech.

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